PATENT ABSTRACTS OF JAPAN

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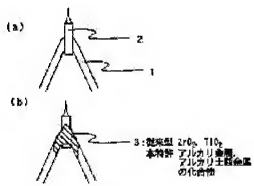
(54) DIFFUSION SUPPLEMENTING TYPE ELECTRON SOURCE AND ELECTRON BEAM-APPLIED APPARATUS EMPLOYING THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a diffusion supplementing type electron source which can emit electrons at high current density and improve the function of an electron beam-applied apparatus needing high current density, for example, improve the drawing speed of an electron beam drawing apparatus.

SOLUTION: In an electron source constituted of a needle-like electrode 2 made of a metal whose tip end is made to be a needle-like shape, a heat radiating body 1 for heating a needle-like electrode 2, and a supplementing source 3 stuck to the needle-like electrode 2, the heat radiating body 1, or their peripheral parts, a material containing oxides of alkali metals or alkaline earth metals, peroxides, hydroxides, nitrides, fluorides, nitrates, or their mixtures is used as the supplementing source. Consequently, an electron source which can easily emit electrons with high current density can be obtained.



Further, drawing speed of an electron beam drawing apparatus can be improved.

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1]A needlelike electrode which comprises metal which made a tip needlelike.
A heating element which heats this needlelike electrode.
Are the diffusion supply type electron source provided with the above, and this electron source has a source of supply which can be heated with this heating element, In this source of supply, an oxide of an alkaline metal or alkaline-earth metals, a peroxide, A substance containing hydroxide, a nitride, a fluoridation thing, nitric acid ghosts, or those mixtures is used, This source substance of supply is diffused to this needlelike electrode tip by heating this heating element, A work function of this needlelike electrode tip surface is decreased by making an adsorption layer in which an alkaline metal, alkaline-earth metals or these elements, oxygen and nitrogen, fluorine, or these elements exist form at this tip of a needlelike electrode.

[Claim 2]By the diffusion supply type electron source according to claim 1, an alkaline metal of the above-mentioned source of supply, Or an oxide of alkaline-earth metals, a peroxide, hydroxide, a nitride, A diffusion supply type electron source, wherein mass percent of a fluoridation thing, a nitric acid ghost or this oxide in a substance containing those mixtures, hydroxide, a nitride, a fluoridation thing, nitric acid ghosts, or those mixtures is not less than 50%.
[Claim 3]A diffusion supply type electron source mixing with pure water to claims 1 and 2, and applying the above-mentioned source substance of supply to them by a diffusion supply type electron source of a statement as a means for making a substance used for the above-mentioned source of supply adhere to the above-mentioned needlelike electrode, the above-mentioned heating element, or these neighborhood.
[Claim 4]A diffusion supply type electron source mixing with an organic matter to claims 1 and 2, and applying the above-mentioned source substance of supply to them by a diffusion supply

type electron source of a statement as a means for making a substance used for the above-mentioned source of supply adhere to the above-mentioned needlelike electrode, the above-mentioned heating element, or these neighborhood.

[Claim 5]A diffusion supply type electron source characterized by including a nitrocellulose in the above-mentioned organic matter by the diffusion supply type electron source according to claim 4.

[Claim 6]To claims 1, 2, 3, 4, and 5, by a diffusion supply type electron source of a statement An alkaline metal of the above-mentioned source of supply, Or an oxide of alkaline-earth metals, a peroxide, hydroxide, a nitride, As a fluoridation thing and a nitric acid ghost, Li2O, Li2O2, LiOH, Li3N, LiF, LiNO3, Na2O, Na2O2, NaOH, Na3N, NaF, NaNO3, K2O, K2O2, KOH, K3N, KF, KNO3, Rb2O, Rb2O2, RbOH, Rb3N, RbF, RbNO3, Cs2O, Cs2O2, CsOH, Cs3N, CsF, CsNO3, Fr2O, Fr -- two -- O -- two -- FrOH -- Fr -- three -- N -- FrF -- FrNO -- three -- BeO -- BeO -- two -- Be -- (-- OH --) -- two -- Be -- three -- N -- two -- BeF -- two -- Be (NO3) -- two, [MgO and] MgO2, Mg(OH)2, Mg3N2, MgF2, Mg(NO3) 2, CaO, CaO2, Ca(OH)2, Ca3N2, CaF2, Ca(NO3) 2, SrO, SrO -- two -- Sr -- (-- OH --) -- two -- Sr -- three -- N -- two -- SrF -- two -- Sr (NO3) -- two -- BaO -- BaO -- two -- Ba -- (-- OH --) -- two -- Ba -- three -- N -- two -- BaF -- two -- Ba (NO3) -- two -- RaO -- RaO -- two -- Ra -- (-- OH --) -- two -- Ra -- three -- N -- two -- RaF -- two -- Ra (NO3) -- two. ******** -- a diffusion supply type electron source characterized by things.

[Claim 7]A diffusion supply type electron source using W, Mo, nickel, Ta, Pt, Ir, Re, and Os for claims 1, 2, 3, 4, and 5 or 6 as the above-mentioned needlelike electrode by a diffusion supply type electron source of a statement.

[Claim 8]By the diffusion supply type electron source according to claim 7, a crystal surface at the tip as the above-mentioned needlelike electrode (100), W, Mo, nickel, Ta and Pt which serve as (110), (211), and a field (111), Ir single crystal or (0001), (10-11), (11-20), (10-10), Re that serves as a field (11-22), a diffusion supply type electron source using Os single crystal.

[Claim 9]By claims 1, 2, 3, 4, 5, 6, and 7 or a diffusion supply type electron source given in 8. A diffusion supply type electron source characterized by operating this needlelike electrode tip at 1000K or less temperature after making an adsorption layer in which an alkaline metal, alkaline-earth metals or these elements, oxygen and nitrogen, fluorine, or these elements exist form at the above-mentioned tip of a needlelike electrode.

[Claim 10]An anode for carrying a diffusion supply type electron source of a statement in claims 1, 2, 3, 4, 5, 6, 7, and 8 or 9, and pulling out an electron from this diffusion supply type electron source, An electron beam device using a diffusion supply type electron source comprising a lens for completing emission electron from this diffusion supply type electron source, deflecting system for making a prescribed position of a sample irradiate with this completed emission electron, and a stage.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the electron source used for electron beam application devices, such as a metering device using an electron beam especially an electron beam lithography system which needs high current density, a scanning electron microscope, and a transmission electron microscope, and these electron beam application devices using the electron source.

[0002]

[Description of the Prior Art]It is important to obtain the electron of high current density from an electron source because of the improvement in observation speed of electron beam application devices, such as improvement in writing speed of an electron beam lithography system and a scanning electron microscope, and a transmission electron microscope. For the electron emission of high current density, it is required to decrease the work function of an electron emission plane. For this reason, these days, the electron source called a diffusion supply type has been used. This is radicalized in a tip on the W filament 1 fabricated by V shape like drawing 1, A tip welds the needlelike electrode 2 of <W< 100 which is 100> direction> single crystal, and zirconium oxide ZrO2 or oxidation titanium TiO2 are made to adhere to the root of the needlelike electrode 2 as the source 3 of supply. Hereafter, it is written as Zr/O/W and Ti/O/W, respectively. The time of operation makes ZrO2 or TiO2 of the source 3 of supply supply and stick to the surface (100) at needlelike electrode 2 tip by thermal diffusion (cooking temperature 1500-1800K). Then, the small adsorption layer (a work function is about 2.7 eV) of a work function is fabricated, and electrons are made to emit by impressing an electric field. These electron sources are used, for example in the electron beam lithography system of a good alloplasia beam method.

[0003]On the other hand, an alkaline metal and alkaline-earth metals stick to a surface of

metal, and the knowledge that a work function decreases is already known (the The Journal OBU chemical physics, the volume 48, p1968 [2421 or]). If O, F, or N gas is made to adsorb in this state, it is also known that there is the further reduction of a work function. For example, if W surface is made to vapor-deposit Cs as an alkaline metal, a work function will be set to -1.0eV if F gas is made to adsorb after that which is set to -1.5eV from -4.5eV. A work function will be set to -2.5eV if W surface is made to vapor-deposit Ba as alkaline-earth metals. It will be set to -2.0eV if O gas is made to adsorb after that. However, the means of metaled vacuum evaporation and gas introduction was required in the vacuum, and when using an alkaline metal, since water and reactivity were dangerous high substances, it was very hard to deal with it by this method.

[0004]

[Problem(s) to be Solved by the Invention]The method of making the above alkaline metals and alkaline-earth metals, and each gas sticking to surfaces of metal, such as W, has a complicated process, and when using an alkaline metal, it is dangerous. This invention solves these problems and proposes the electron source from which high current density is obtained rather than Zr/O/W and Ti/O/W.

[0005]On the other hand, although conventional-type electron source Zr/O/W and Ti/O/W were used in the electron beam application device, for example, the electron beam lithography system of a good alloplasia beam method, there was a fault that there was little emission current from an electron source, and writing speed was slow. Therefore, if the circuit pattern of 256 M bytes of DRAM (Dynamic Random Access Memory) is drawn, it will take several hours, for example. However, in order to include this DRAM in a factory line, to carry out writing speed in several minutes is desired. This invention solves the technical problem of this writing speed.

[0006]

[Means for Solving the Problem]A needlelike electrode, a needlelike electrode of an electron source constituted with a heating element, a heating element, or a substance that contains an oxide of an alkaline metal or alkaline-earth metals, a peroxide, hydroxide, a nitride, a fluoridation thing, nitric acid ghosts, or those mixtures in these neighborhood is made to adhere as a source of supply. As the above-mentioned oxide, a peroxide, hydroxide, a nitride, a fluoridation thing, and a nitric acid ghost, specifically, Li2O, Li2O2, LiOH, Li3N, LiF, LiNO3, Na2O, Na2O2, NaOH, Na3N, NaF, NaNO3, K2O, K2O2, KOH, K3N, KF, KNO3, Rb2O, Rb2O2, RbOH, Rb3N, RbF, RbNO3, Cs2O, Cs2O2, CsOH, Cs3N, CsF, CsNO3, Fr2O, Fr2O2, FrOH, Fr3N, FrF, FrNO3, BeO, BeO2, Be(OH)2, Be3N2, BeF2, Be(NO3)2, MgO, MgO2, Mg (OH)2, Mg3N2, MgF2, Mg(NO3) 2, CaO, CaO2, Ca(OH)2, Ca3N2, CaF2, Ca(NO3) 2, SrO, SrO -- two -- Sr -- (-- OH --) -- two -- Sr -- three -- N -- two -- SrF -- two -- Sr (NO3) -- two -- BaO -- BaO -- two -- Ba -- (-- OH --) -- two -- Ba -- three -- N -- two -- BaF -- two -- Ba (NO3) --

two -- RaO -- RaO -- two -- Ra -- (-- OH --) -- two -- Ra -- three -- N -- two -- RaF -- two -- Ra (NO3) -- two -- it comes out. As a means made to adhere, what dissolved this source of supply in paste state with an organic matter containing pure water or a nitrocellulose is used. Then, a source substance of supply is diffused to a needlelike electrode tip by heating a heating element. (100), (110), a crystal surface at the tip as a needlelike electrode, It is good to use W, Mo, nickel, Ta and Pt which serve as (211) and a field (111), Ir single crystal or (0001), (10-11), (11-20), (10-10), Re that serves as a field (11-22), and Os single crystal. However, a crystal face used here follows a notation of Table 1.

[0007]

[Table 1]

表 1

	文章中で用いる記号	意味
結晶面	(10−11)	$(10\bar{1}1)$
	(11−20)	$(11\bar{2}0)$
	(10−10)	$(10\bar{1}0)$
	(11−22)	$(11\bar{2}2)$

[0008]

[Embodiment of the Invention]

(Example 1) Drawing 1 (a) and (b) explains the first example of this invention. First, the crystal orientation of the length direction carries out point soldering of the <W< 100 which is 100>> single crystal at 0.127 mm in diameter at the tip of 0.127 mm in diameter the heating element 1 made from the tungsten (W) fabricated by V shape, The tip was keenly sharpened in curvature radius of about 200 nm by electrolytic polishing in the sodium hydroxide solution of 5% of concentration, and the needlelike electrode 2 (length -1mm) was created (drawing 1 (a)). Next, it dissolved in paste state with pure water, and the powder of RbF was made to adhere to the joint part neighborhood of the heating element 1 and the needlelike electrode 2 as the source 3 of supply (drawing 1 (b)). Then, energizing heating of the heating element 1 is carried out in the vacuum more than the -10th power of the ten degree of vacuum Torr, temperature of the needlelike electrode 2 is made about 700K, and source of supply 3 substance was diffused and was made to adsorb to the tip part of the needlelike electrode 2. Thus, the work function of the surface (100) at needlelike electrode 2 tip was decreased. Then, in order to make the material diffused from the source of supply adsorb stably, temperature of the needlelike electrode 2 was set to 300K. It countered at the tip of a needlelike electrode in this state, and the extraction electrode has been arranged, and when negative drawer voltage was applied to the electron source, with the extraction electrode grounded, it became like Rb/F/W of drawing 2. The value (Zr/O/W in a figure, operating temperature 1800K) which uses zirconium oxide as a charge of a dispersing agent for reference was also shown. Here, a horizontal axis is an absolute value of drawer voltage, and a vertical axis is radiation angle current density. For

example, when the voltage of 1 kV was applied, radiation angle current density bigger about 100 times than the electron source which uses zirconium oxide was obtained. According to this method, time and effort of Rb vacuum evaporation within a vacuum housing and F gas introduction into a vacuum housing was not needed, but handling became easy. Danger was also able to be avoided by using RbF more stable than Rb.

[0009]As a source of supply, Li2O, Li2O2, LiOH, Li3N, LiF, LiNO3, Na2O, Na2O2, NaOH, Na3N, NaF, NaNO3, K2O, K2O2, KOH, K3N, KF, KNO3, Rb2O, Rb2O2, RbOH, Rb3N, RbF, RbNO3, Cs2O, Cs2O2, CsOH, Cs3N, CsF, CsNO3, Fr2O, Fr -- two -- O -- two -- FrOH -- Fr -- three -- N -- FrF -- FrNO -- three -- BeO -- BeO -- two -- Be -- (-- OH --) -- two -- Be -- three -- N -- two -- BeF -- two -- Be (NO3) -- two, [MgO and] MgO2, Mg(OH)2, Mg3N2, MgF2, Mg(NO3) 2, CaO, CaO2, Ca(OH)2, Ca3N2, CaF2, Ca(NO3) 2, SrO, SrO2, Sr(OH)2, Sr3N2, SrF2, Sr (NO3) 2, BaO, BaO -- two -- Ba -- (-- OH --) -- two -- Ba -- three -- N -- two -- BaF -- two -- Ba (NO3) -- two -- RaO -- RaO -- two -- Ra -- (-- OH --) -- two -- Ra -- three -- N -- two -- RaF -- two -- Ra (NO3) -- two -- or -- these -- a mixture -- containing -- a substance -- using -- even if -- being the same -- an effect -- obtaining -- having had . (100), (110), the crystal surface at the tip as the needlelike electrode 2, The same effect was acquired even if it used Re and Os single crystal which serve as W, Mo, nickel, Ta and Pt which serve as (211) and a field (111), Ir single crystal or (0001), (10-11), (11-20), (10-10), and a field (11-22).

[0010](Example 2) The example of the variable shaped beam type electron beam lithography system which carries the diffusion supply type electron source of a statement in Example 1 is shown in drawing 3. The anode 302 is directly under the diffusion supply type electron source 301, and high-pressure extraction voltage is given between the diffusion supply type electron source 301 and the anode 302. After the electron 316 pulled out from the diffusion supply type electron source 301 passes through the hole which was able to be made in the center of the anode 303 and fabricates a beam using the 1st transfer mask 303 and the 2nd transfer mask, projection of a beam is performed by the object lens 312 and it is exposed by the target 313. The cooking temperature of the diffusion supply type electron source 301, the extraction voltage of the anode 302, each projector lenses 305 and 307, the object lens 312, the blanker 304, the transfer deflecting system 306, the deflecting system 311, and the reflection electron detector 315 are controlled by the control computer 317.

[0011]Circuit pattern drawing of 256 M bytes of DRAM was tried using such a device. As a result, comparison of the case where conventional Zr/O/W is used as a diffusion supply type electron source, and this device will have shortened in 5 minutes what had taken 3 hours. Improvement in an inspection throughput has been realized by using this diffusion supply type electron source for the scanning electron microscope of semiconductor device evaluation checking, or a transmission electron microscope besides an electron beam lithography system.

[0012]

[Effect of the Invention]According to this invention, the work function of an electron emission plane can be decreased easily, and an electron source with the electron emission of high current density can be manufactured. The improved efficiency of the electron beam application device which needs high current density, for example, the improvement in writing speed of an electron beam lithography system, is made possible.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a formation process figure of the diffusion supply type electron source example 1 of this invention.

[Drawing 2]It is an experimental result of the drawer voltage of a diffusion supply type electron source, and radiation angle current density concerning this invention.

[Drawing 3]It is a lineblock diagram of the electron beam lithography system which carries the diffusion supply type electron source of this invention.

[Description of Notations]

1: Heating element 2: Needlelike electrode 3: Source of supply 301: Diffusion supply type electron source 302: Anode 303: The first transfer mask 304: Blanker 305: Projector lens 306: Transfer deflecting system 307: Projector lens 308: The second transfer mask 309: Blanking aperture 310: Body tube 311: Deflecting system 312: Object lens 313: Target 314: Stage 315: Reflection electron detector 316: Electron 317: Control computer.

[Translation done.]

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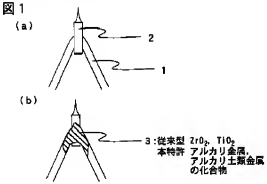
DRAWINGS

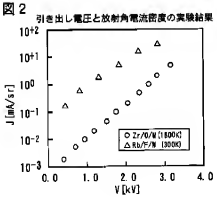
[Drawing 1]

図1



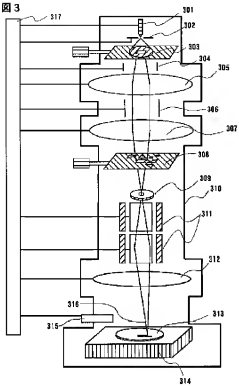
[Drawing 2]

図2



[Drawing 3]

図3



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